Attorney Docket No. 5051-668 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application: Velev
Application No.: 10/755,843
Filed: January 12, 2004
For: *Droplet Transportation Devices and Methods Having a Fluid Surface*

Confirmation No.: 8437
Group Art Unit: 1753
Examiner: Allison Leigh Watts

Date : April 14, 2008

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPELLANT'S BRIEF ON APPEAL UNDER 37 C.F.R. § 41.67

Sir:

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" filed February 12, 2008.

Real Party In Interest

The real party in interest is assignee North Carolina State University.

Related Appeals and Interferences

Appellant is aware of no appeals or interferences that would be affected by the present appeal.

Status of Claims

Claims 1, 2, 4-19 and 21-37 are pending and stand rejected. Appellant appeals the final rejection of Claims 1, 2, 4-19 and 21-37 by the Final Office Action dated September 12, 2007 (the Action). Claims 1, 2, 4-10, 12-19, 21-30 and 32-37 stand rejected in the Action under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,294,063 to Becker ("Becker"). Claims 11 and 31 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Becker in view of U.S. Patent No. 6,149,789 to Benecke et al. ("Benecke").

Status of Amendments

The Appendix of Claims submitted herewith reflects the state of the claims of record. No amendments have been filed subsequent to the Final Action.

Summary of Claimed Subject Matter

Independent Claim 1 recites a device **10** for the manipulation of a suspended particle in an electric field. *See* page 4, lines 18-19; Figure 1. The device **10** includes a plurality of electrically isolated electrodes **14A-14F** on a surface **17**. *See* page 4, lines 19-20; Figure 1. A liquid composition **16** is on the plurality of electrodes **14A-14F**. *See* page 4, lines 20-21; Figure 1. The liquid composition **16** covers the surface **17** continuously between adjacent ones of the plurality of electrodes **14A-14F**. *See* page 4, lines 20-21; Figure 1. The liquid composition **16** has an exposed liquid surface for suspending a particle **12**. *See* page 4, lines 23-24; Figure 1. The plurality of electrodes **14A-14F** are configured to provide an electric field gradient for transporting the particle **12** suspended in the liquid composition. *See* page 5, lines 17-20; Figure 1. A particle is suspended in the liquid composition **16**. *See* page 5, lines 12-15; Figure 1. The particle **12** does not directly contact the plurality of electrodes **14A-14F**. *See* page 4, lines 23-24; Figure 1.

Independent Claim 18 recites a method for the manipulation of a suspended particle in an electric field gradient. A plurality of electrodes **14A-14F** is configured on a surface **17** to provide an electric field gradient for transporting a particle **12**. *See* page 4, lines 19-20; Figure 1. A liquid composition **16** is applied on the plurality of electrodes **14A-14F**. page 4, lines 20-21; Figure 1. The liquid composition **16** has an exposed liquid surface for suspending a particle **12**. *See* page 4, lines 23-24; Figure 1. The particle **12** is suspended in the liquid composition **16**. *See* page 5, lines 12-15; Figure 1. A voltage is applied between selected ones of the plurality of electrodes **14A-14F** to provide an electric field gradient. *See* page 5, lines 12-23; Figure 1. The electric field gradient has a pattern that defines a pathway for transporting the particle **12**. *See* page 5, lines 12-23; Figure 1. The particle **12** is transported along the pathway defined by the electric field gradient. The particle **12** does not directly contact the plurality of electrodes **14A-14F**. *See* page 4, lines 23-24; page 5, lines 12-23; Figure 1.

Grounds of Rejection to be Reviewed on Appeal

1. Whether Claims 1, 2, 4-19 and 21-37 are properly rejected under 35 U.S.C. 102(b) as being anticipated by Becker and/or under 35 U.S.C. 103(a) as being unpatentable over Becker and Benecke.

Argument

With respect to anticipation under 35 U.S.C. § 102, "[a] claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). *See* M.P.E.P. § 2131.

Independent Claim 1 recites a device for the manipulation of a suspended particle in an electric field gradient including:

> a plurality of electrically isolated electrodes on a surface; and
> a liquid composition on said plurality of electrodes, said liquid composition covering said surface continuously between adjacent ones of said plurality of electrodes, said liquid composition having an exposed liquid surface for suspending a particle;
> said plurality of electrodes configured to provide an electric field gradient for transporting the particle suspended in said liquid composition; and
> a particle suspended in said liquid composition, wherein said particle does not directly contact said plurality of electrodes.

Independent Claim 18 recites a method for the manipulation of a suspended particle in an electric field gradient including:

> configuring a plurality of electrodes on a surface to provide an electric field gradient for transporting a particle;
> applying a liquid composition on the plurality of electrodes, the liquid composition having an exposed liquid surface for suspending a particle;
> suspending the particle in the liquid composition;
> applying a voltage between selected ones of the plurality of electrodes to provide the electric field gradient, the electric field gradient having a pattern that defines a pathway for transporting the particle; and
> transporting the particle along the pathway defined by the electric field gradient, wherein the particle does not directly contact the plurality of electrodes.

Appellant submits that Becker does not disclose or render obvious an exposed liquid surface for suspending a particle, a plurality of electrodes configured to provide an electric field gradient for transporting the particle suspended in the liquid composition, and that the particle does not directly contact the plurality of electrodes as recited in independent Claims 1 and 18. Moreover, Becker does not disclose or render obvious transporting the particle along the pathway defined by the electric field gradient, wherein the particle does not directly contact the plurality of electrodes as recited in Claim 18.

As shown, for example, in Figure 1A of the current application, a microdroplet **12** is suspended in a liquid **16** (for example, fluorinated oil) that has an exposed surface **16A**. As noted on page 4, line 23, an "exposed" surface means that the surface **16A** is in open contact with the surrounding air. According to embodiments of the current invention and as illustrated in Figure 1A, the droplet **12** is not in contact with any of the solid surfaces of the device 10, such as the solid surfaces of the electrodes **14A-14F** or the substrate **17**. In this configuration, surface fowling, evaporation, adsorption of the droplet **12** (or components carried by the droplet **12**), and chip contamination may be reduced. Figure 1A of the current application is reproduced below.

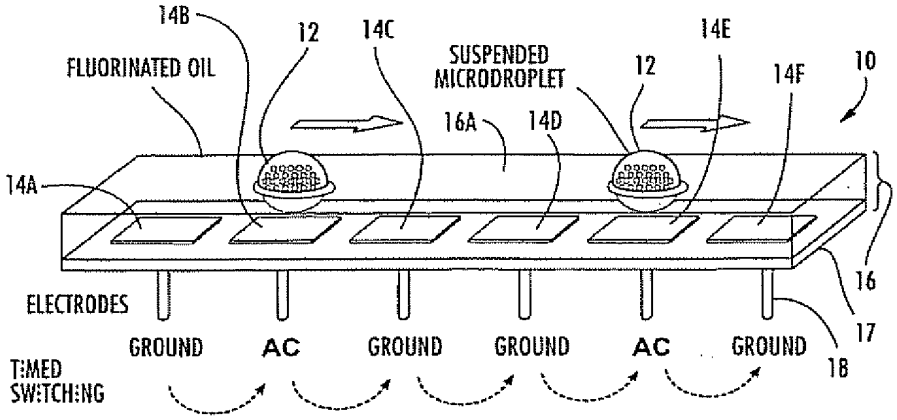

FIG. 1A

The Examiner erroneously interprets the device in Becker as including 10^{13} particles that are "well distributed throughout the fluid." *See* the Action, page 4. The Examiner somehow concludes that "[o]ut of 10^{13} particles in the liquid composition of Becker, many or most of those particles would never directly contact the plurality of electrodes and these particles would meet the claim limitation." *See id.* Appellant submits that the Examiner's

interpretation of Becker is unreasonable. Moreover, the analysis in the Action ignores various recitations of the claims.

As shown in Figure 8 (reproduced below), Becker discusses a device **10** in which the electrodes **43** are positioned on a reaction surface **12** in a chamber **41** (*see* Becker, col. 7, lines 37-41 and col. 18, lines 26-33), and Becker states that the reaction surface **12** is configured to provide an interaction site for the packets. *See* Becker, col. 3, lines 20-21 and Claim 1. Becker further discusses that the electrodes can include coatings, such as a 2 nm to 1 micron thick dielectric layer, on the reaction surface **12** that "may prevent an aqueous packet from sticking, from spreading, or from becoming unstable upon contact with reaction surface **12**" or that modify interaction forces on the reaction surface **12**. *See* Becker, col. 12, lines 4-6 (emphasis added); col. 25, lines 29-35.

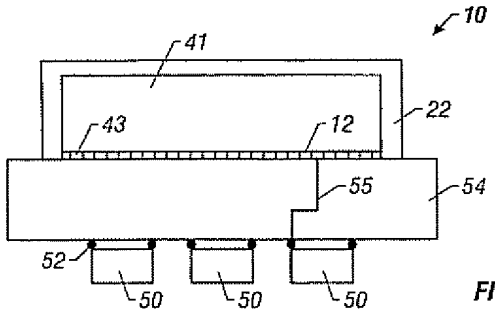

FIG. 8

The Examiner erroneously presumes that the supposed 10^{13} particles would be "well distributed" because the liquids utilized by Becker have densities either at or slightly below the density of the water being suspended. *See* the Action, page 4. The Examiner bases his determination that Becker manipulates 10^{13} "evenly distributed" particles on a calculation from Example 1 ("Packets have been formed by briefly sonicating about 3 milliliters of the hydrophobic liquid to which has been added 20 to 50 microliters of aqueous water...." (col. 26, lines 13-22)) and a particle diameter as low as 100 nm (col.3, lines 14-16) because "the volume of a 100 nm diameter spherical particle would be on the order of 10^{-19} liters." *See* the Action, pages 3-4. However, the packets of Becker are introduced to the device via a port **14** so that the packets are precisely deposited on specific locations (*see* col. 12, lines 52-56), and therefore, Appellant submits that it is unclear from the disclosure of Becker just how many of the packets are introduced at a given time in the device.

However, even if the device in Becker were able to include 10^{13} packets, the Examiner's discussion of 10^{13} supposedly "well distributed" particles ignores Becker's clear

discussion of packet control and manipulation on a reaction surface **12**. Becker states that a force generator **25** generates forces that manipulate packets **21**. A position sensor **23** senses the position of the packets and is able to monitor packet interactions. *See* col. 7, lines 45-62.

> The position of packets during manipulation may thus be continuously monitored and this information may be used to continuously adjust one or more manipulation forces so to achieve movement of packets **21** along a desired trajectory to a desired location on the reaction surface **12**.

Col. 7, lines 57-62 (emphasis added).

Becker further states that "[a] micropipette or any other equivalent device may be attached to a micromanipulation stage (not shown in Figure 4) so that material may be precisely deposited **onto** specific locations of reaction surface **12**." *See* col. 12, lines 52-56 (emphasis added).

Therefore, even if Becker's device includes 10^{13} particles, the particles are clearly not "well distributed throughout the fluid" as maintained by the Examiner. Instead, the movement and position of the packets in Becker are precisely controlled on the reaction surface **12**. Moreover, even if one of the particles of Becker did not contact the electrodes, Becker would still not meet the recitation that a plurality of electrodes are configured to provide an electric field gradient for transporting the particle suspended in the liquid composition, **and** that the particle does not directly contact the plurality of electrodes as recited in independent Claims 1 and 18.

Becker also does not disclose or render obvious transporting the particle along the pathway defined by the electric field gradient, **and** that the particle does not directly contact the plurality of electrodes as recited in Claim 18.

In addition, Becker proposes that the reaction surface **12** provides an interaction site where the packets apparently contact the electrode array **43**, and as such, Becker teaches away from configurations in which the particle does not directly contact the electrodes as recited in independent Claims 1 and 18.

Benecke is cited in the Action with respect to Claims 11 and 31 as allegedly disclosing ring-shaped electrodes. Accordingly, Appellant submits that Benecke does not remedy the deficiencies of Becker.

For at least these reasons, Appellant submits that Becker and Benecke do not disclose or render obvious the recitations of independent Claims 1 and 18. Appellant respectfully

requests that the rejections of Claims 1 and 18 and Claims 2, 4-17, 19 and 21-37 depending therefrom be reversed.

CONCLUSION

In view of the above discussion, Appellant submits that the rejection of Claims 1, 2, 4-19 and 21-37 should be reversed and the present application passed to issue.

Respectfully submitted,

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CERTIFICATION OF ELECTRONIC TRANSMISSION

I hereby certify that this correspondence is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4) to the U.S. Patent and Trademark Office on April 14, 2008.

Joyce Paoli

Claims Appendix

1. (Previously Presented) A device for the manipulation of a suspended particle in an electric field gradient comprising:

a plurality of electrically isolated electrodes on a surface; and

a liquid composition on said plurality of electrodes, said liquid composition covering said surface continuously between adjacent ones of said plurality of electrodes, said liquid composition having an exposed liquid surface for suspending a particle;

said plurality of electrodes configured to provide an electric field gradient for transporting the particle suspended in said liquid composition; and

a particle suspended in said liquid composition, wherein said particle does not directly contact said plurality of electrodes.

2. (Original) The device of Claim 1, wherein said liquid composition is selected from the group consisting of perfluorinated oil, silicone oil, fluorocarbons, hydrocarbons, and/or chemical and/or physical combinations thereof.

3. (Canceled).

4. (Original) The device of Claim 1, wherein said particle comprises a solid particle.

5. (Original) The device of Claim 3, wherein said particle comprises a fluid droplet.

6. (Original) The device of Claim 5, wherein said fluid droplet includes a carried component suspended, dissolved, or solubilized therein.

7. (Original) The device of Claim 6, wherein said fluid droplet comprises water and said carried component is selected from the group consisting of nanoparticles, microparticles, surfactants, proteins, cells, viruses, drugs, toxins, chemical compounds, or combinations thereof.

8. (Original) The device of Claim 6, wherein said fluid droplet comprises hydrocarbon or an organic compound and said carried component is selected from the group consisting of nanoparticles, microparticles, polymers, polymerizable monomers, surfactants, silicone compounds, and/or combinations thereof.

9. (Original) The device of Claim 5, wherein said fluid droplet has a volume between about 0.01 μL and about 10 μL.

10. (Original) The device of Claim 1, wherein said plurality of electrodes are configured to provide a first pathway for a first particle and a second pathway for a second particle, said first pathway and said second pathway having an intersection for combining said first particle and said second particle.

11. (Original) The device of Claim 1, wherein ones of said plurality of electrodes comprises a conductive ring.

12. (Original) The device of Claim 1, wherein said plurality of electrodes are configured in a two-dimensional matrix.

13. (Original) The device of Claim 11, wherein said surface includes a first side having said plurality of electrodes positioned thereon, and a second side having a plurality of leads electrically connected to said plurality of electrodes, ones of the plurality of leads being connected to an alternating current source, a direct current source or ground, wherein the positions of said plurality of electrodes are selected to provide a dynamic non-uniform electric field pattern for transporting a particle along a pathway.

14. (Original) The device of Claim 11, wherein said plurality of electrodes have a length of between about 0.1 and about 1 mm and a distance between adjacent ones of said plurality of electrodes between about 0.1 mm and about 1 mm.

15. (Original) The device of Claim 1, further comprising a power source connected to said plurality of electrodes, said power source configured to provide an alternating current (AC) voltage of between about 50 V and about 500 V at a frequency between about 50 Hz and about 500 Hz to ones of said plurality of electrodes.

16. (Original) The device of Claim 1, further comprising a power source connected to said plurality of electrodes, said power source configured to provide a direct current (DC) voltage between about 20 and about 500 V to ones of said plurality of electrodes.

17. (Original) The device of Claim 1, wherein said plurality of electrodes are configured to provide an electric field gradient for applying force to a droplet suspended in the liquid fluid in opposing directions for separating the droplet into two droplets.

18. (Previously Presented) A method for the manipulation of a suspended particle in an electric field gradient comprising:

configuring a plurality of electrodes on a surface to provide an electric field gradient for transporting a particle;

applying a liquid composition on the plurality of electrodes, the liquid composition having an exposed liquid surface for suspending a particle;

suspending the particle in the liquid composition;

applying a voltage between selected ones of the plurality of electrodes to provide the electric field gradient, the electric field gradient having a pattern that defines a pathway for transporting the particle; and

transporting the particle along the pathway defined by the electric field gradient, wherein the particle does not directly contact the plurality of electrodes.

19. (Original) The method of Claim 18, wherein the liquid composition is selected from the group consisting of perfluorinated oil, silicone oil, fluorocarbons, hydrocarbons, and/or chemical and/or physical combinations thereof.

20. (Canceled).

21. (Original) The method of Claim 20, wherein the particle comprises a solid particle.

22. (Original) The method of Claim 20, wherein the particle comprises a fluid droplet.

23. (Original) The method of Claim 22, wherein the fluid droplet further comprises a carried component suspended, dissolved, or solubized therein.

24. (Original) The method of Claim 23, wherein the fluid droplet comprises water and the carried component is selected from the group consisting of nanoparticles, microparticles, surfactants, proteins, cells, viruses, drugs, toxins, chemical compounds, or combinations thereof.

25. (Original) The method of Claim 23, wherein the fluid droplet comprises hydrocarbon or an organic material and the carried component is selected from the group consisting of a nanoparticle, a microparticle, a polymer, a polymerizable monomer, a surfactant, a silicone compound, and/or combinations thereof.

26. (Original) The method of Claim 23, wherein the fluid droplet has a volume between about 0.01 μL and about 10 μL.

27. (Original) The method of Claim 18, wherein the pattern of the electric field gradient further defines a second pathway, the first pathway and the second pathway having a common intersection, the method comprising:

transporting a second particle along the second pathway; and

combining the first particle and the second particle at the intersection between the first pathway and the second pathway.

28. (Original) The method of Claim 27, wherein the first droplet and the second droplet comprise constituents of an assay.

29. (Original) The method of Claim 27, further comprising chemically reacting constituents of the first droplet with constituents of the second droplet.

30. (Original) The method of Claim 27, wherein said combining step further comprises forming a solid and/or encapsulated particulate product.

31. (Original) The method of Claim 18, wherein ones of the plurality of electrodes comprises a conductive ring.

32. (Original) The method of Claim 18, further comprising configuring said plurality of electrodes in a two-dimensional matrix.

33. (Original) The method of Claim 18, wherein the surface includes a first side having the plurality of electrodes positioned thereon, and a second side having a plurality of leads electrically connected to the plurality of electrodes, further comprising:

connecting ones of the plurality of leads to an alternating current source, a direct current source or ground; and

selecting the positions of the plurality of electrodes to provide a dynamic non-uniform electric field pattern for transporting the particle along the pathway.

34. (Original) The method of Claim 18, wherein ones of the plurality of electrodes have a length of between about 0.1 and about 1 mm and the distance between electrodes ranges from between about 0.1 mm to about 1 mm.

35. (Original) The method of Claim 18, further comprising applying an alternating current (AC) voltage of between about 50 V and about 500 V at a frequency between about 50 Hz and about 500 Hz to ones of the plurality of electrodes.

36. (Original) The method of Claim 18, further comprising applying a direct current (DC) voltage between about 20 and about 500 V to ones of the plurality of electrodes.

37. (Original) The method of Claim 18, further comprising:

providing an electric field gradient that applies force to a droplet suspended in the liquid fluid in two directions; and

separating the droplet into two droplets by applying the electric field gradient.

Evidence Appendix

NONE

Related Proceedings Appendix

NONE